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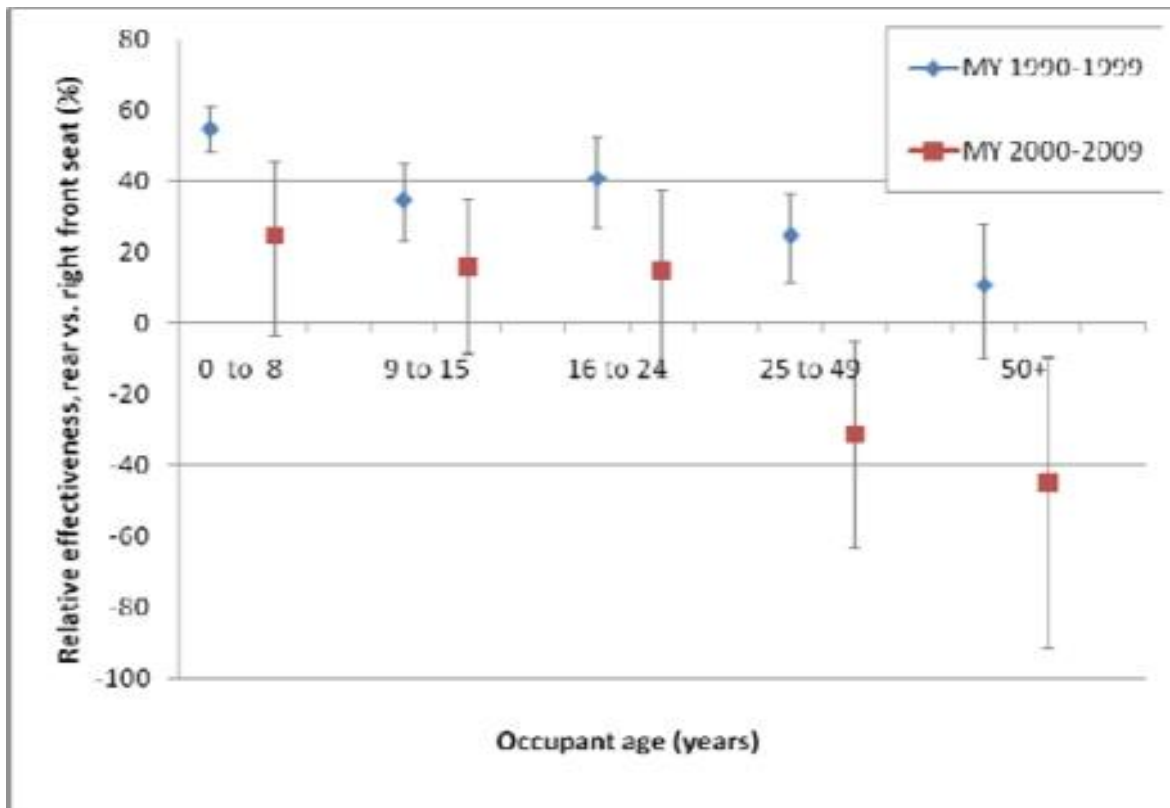
Rear Seat Safety: Targeted Areas of Future Focus

Kristy B. Arbogast, PhD
**Center for Injury Research and
Prevention**
**Children's Hospital of
Philadelphia**

2016 NTSB Workshop
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Historical benefits of rear seating diminishing



Rear seat less protective relative to the front in newer model year vehicles

Advances in safety technology have lagged in the rear

Relative effectiveness of rear vs. right front seat for belted occupants

Sahraei et al. *Proc AAAM*, 2010

Rear seat safety

Targeted issues for the future

1. Engineering improvements to rear seat protection
 - How to advance consumer information programs and regulations
2. Varied restraint options and behavior in rear seat
 - How do we simplify usage?
 - How do we make typical behavior safe?

1. Engineering optimization of rear seat

First...need to know

- Who sits there?
- What is their risk of injury?
 - By age and model year
- How does that risk of injury compare to risk in the front seat?

Sources of Data

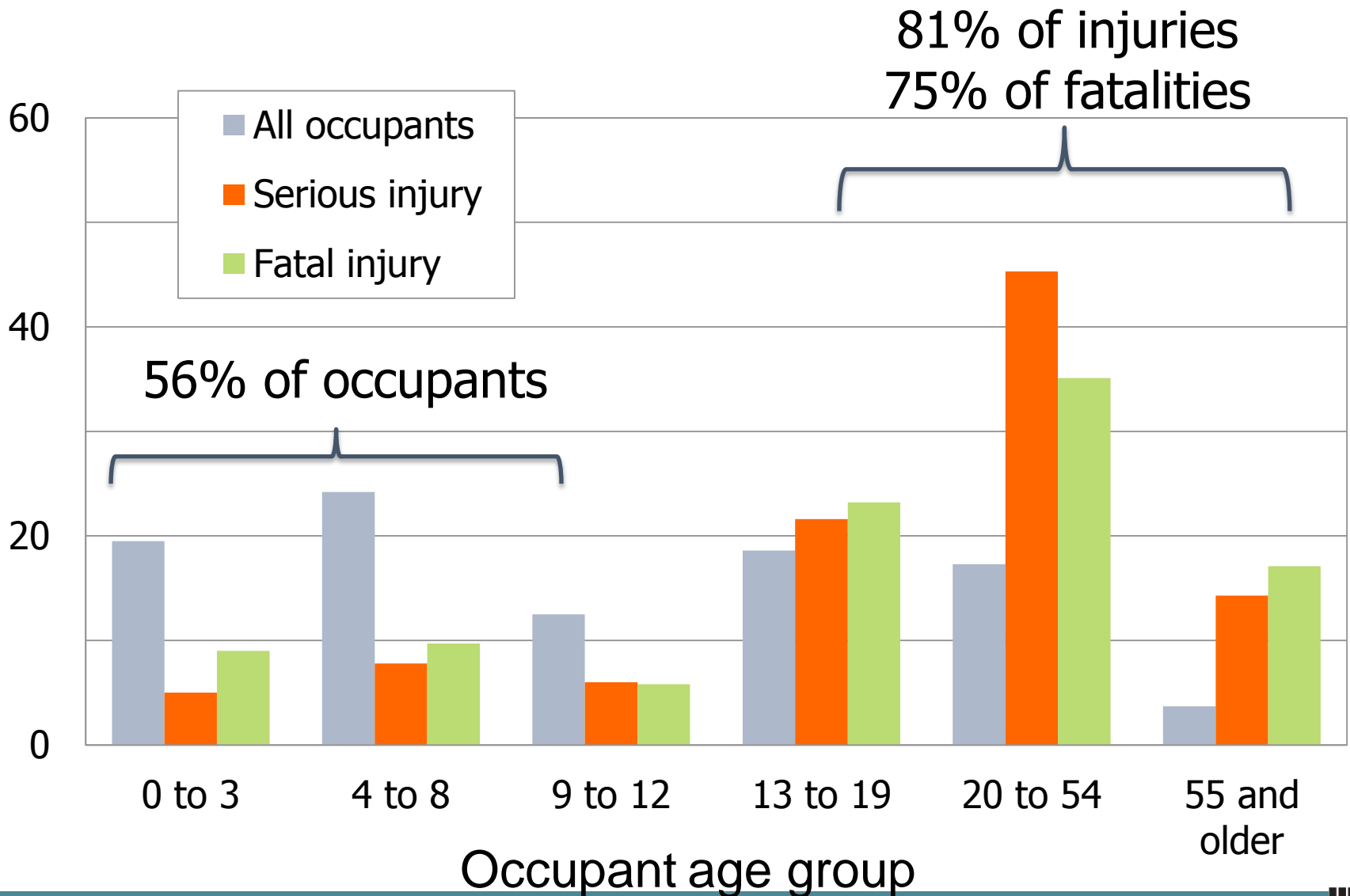
- NASS-CDS, 2007-2012; FARS, 2007-2012
- Passenger Vehicles restricted to MY 2000 and newer and ≤ 10 years old

Combined FARS and NASS-CDS data

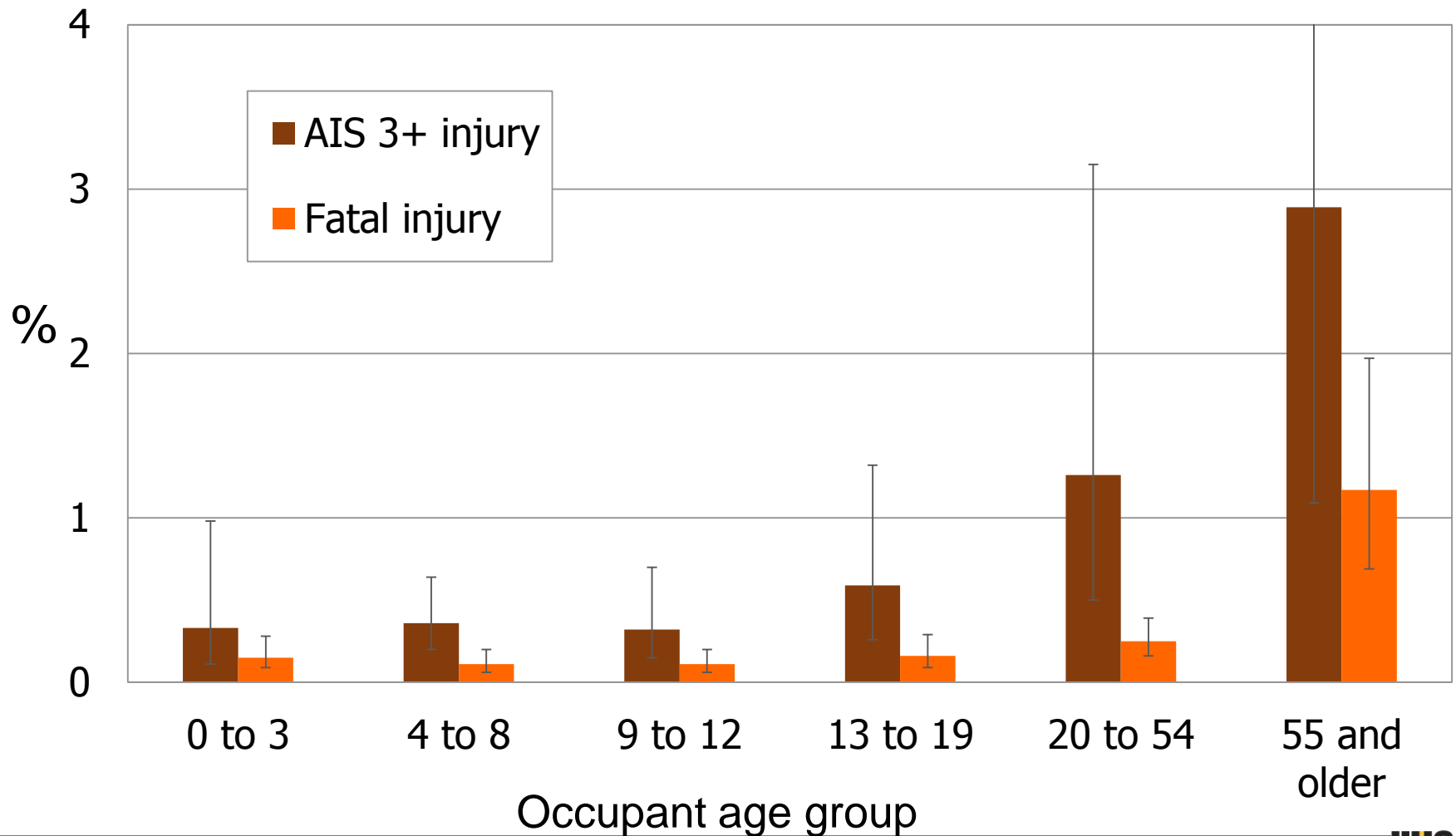
- FARS cases substituted for all weighted fatality cases in NASS

Serious injury: AIS 3+

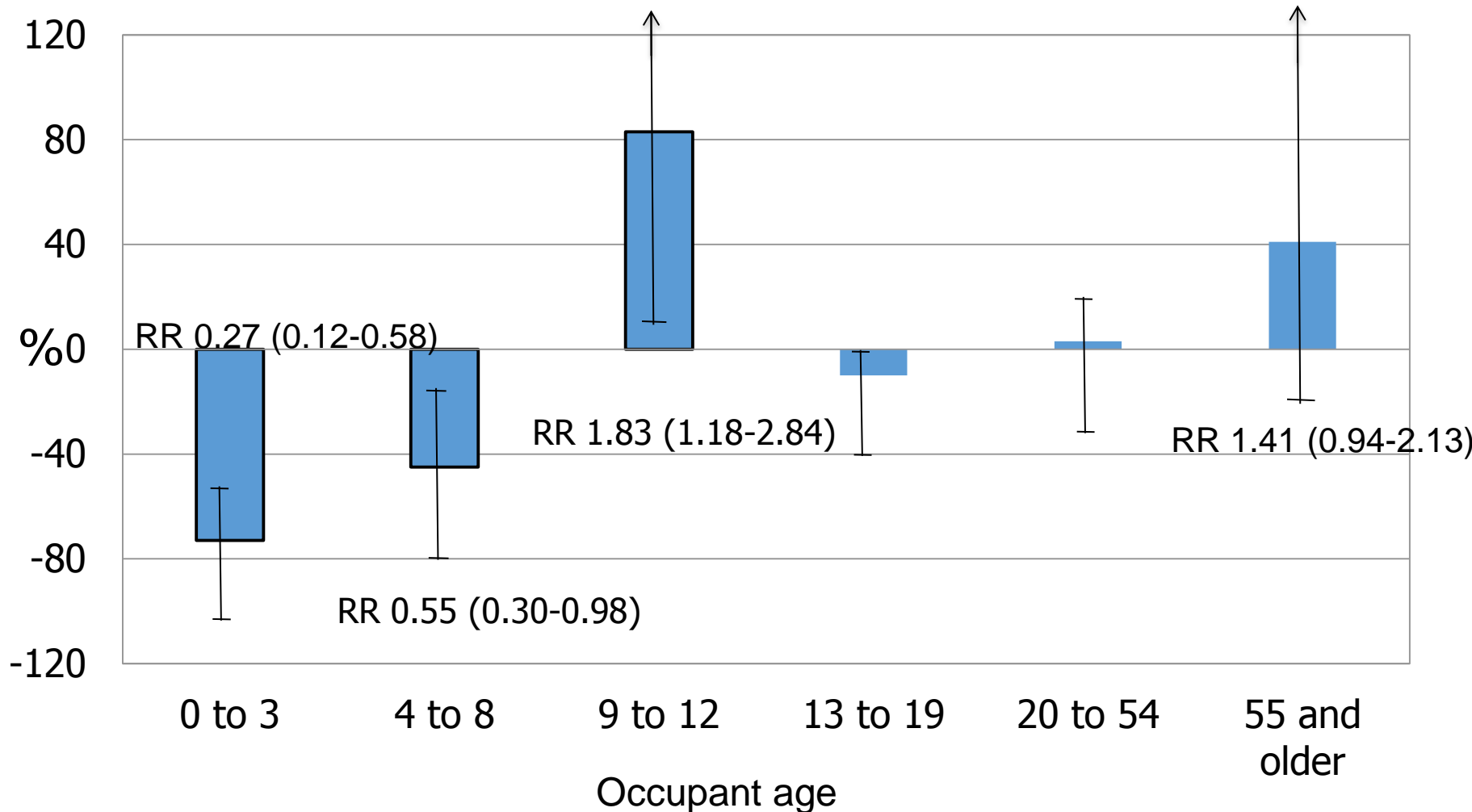
Age distribution in the rear



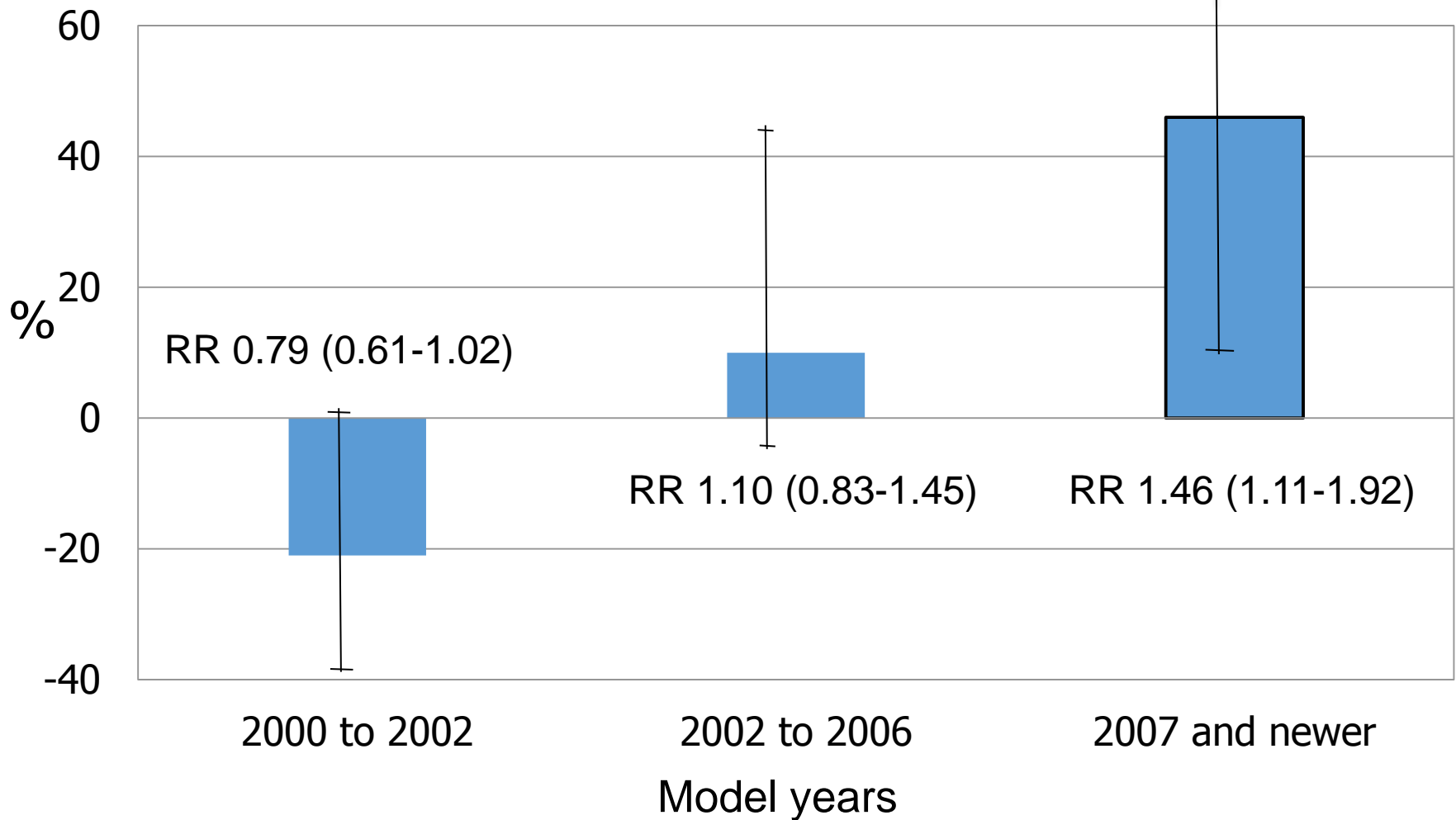
Risk of serious or fatal injuries by age among restrained rear row occupants



Difference in risk of fatal injury for rear vs. front row passengers by occupant age



Difference in risk of fatal injury for rear vs. front row passengers by vehicle MY



1. Engineering optimization of rear seat

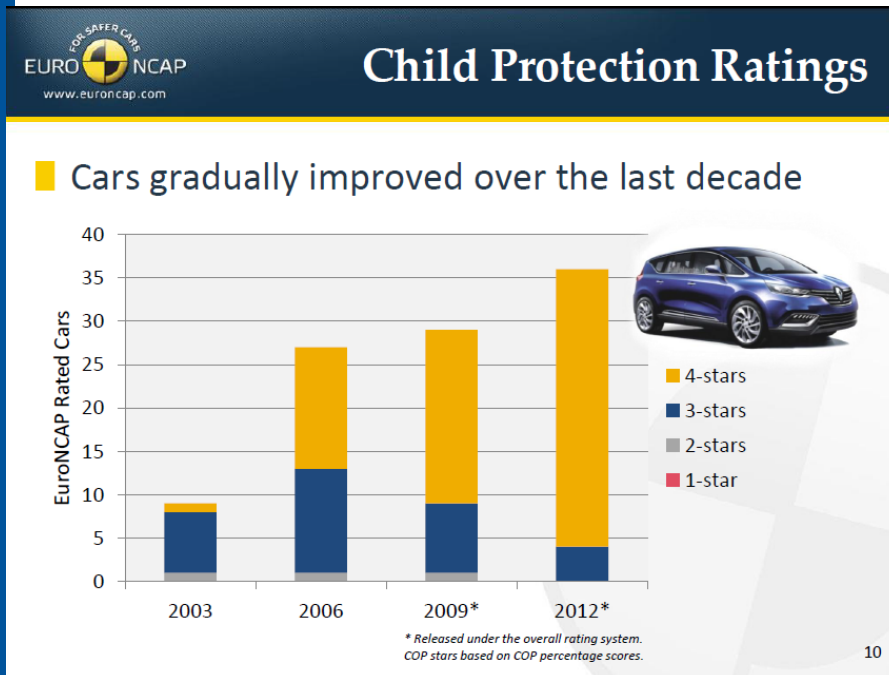
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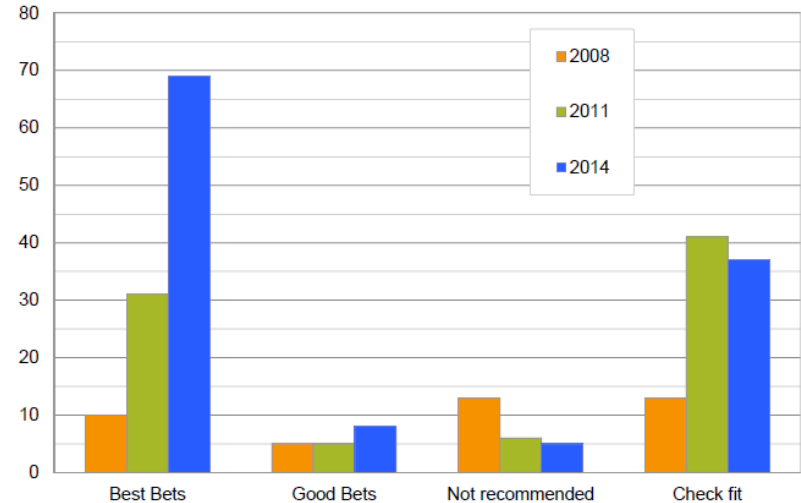
Second... how do we improve protection?

Regulation is a Minimum Standard

- May not always incorporate all current knowledge of biomechanics or crashworthiness – ATD or test method limitations
- Consumer ratings can be a powerful companion



IIHS Booster Fit Ratings



US Consumer Information Programs



Frontal impact

Driver
Right front passenger

Side impact

Driver
Right rear (small
adult) passenger



Driver

Driver
Right rear (small
adult) passenger



From recent EuroNCAP news release...

"Almost all new cars in this release not only offer low and/or high speed autonomous braking (AEB) systems ..., but also have incorporated more advanced restraint technology on the rear seats to cope with the newest full-width frontal crash test."



5-STAR SAFETY RATINGS FOR THE FUTURE



- A frontal oblique crash test
- Use of a 5th percentile female dummy to enhance safety of rear seat
- New adult crash test dummies for driver tests
- A pedestrian rating
- Crash avoidance and new technology rating

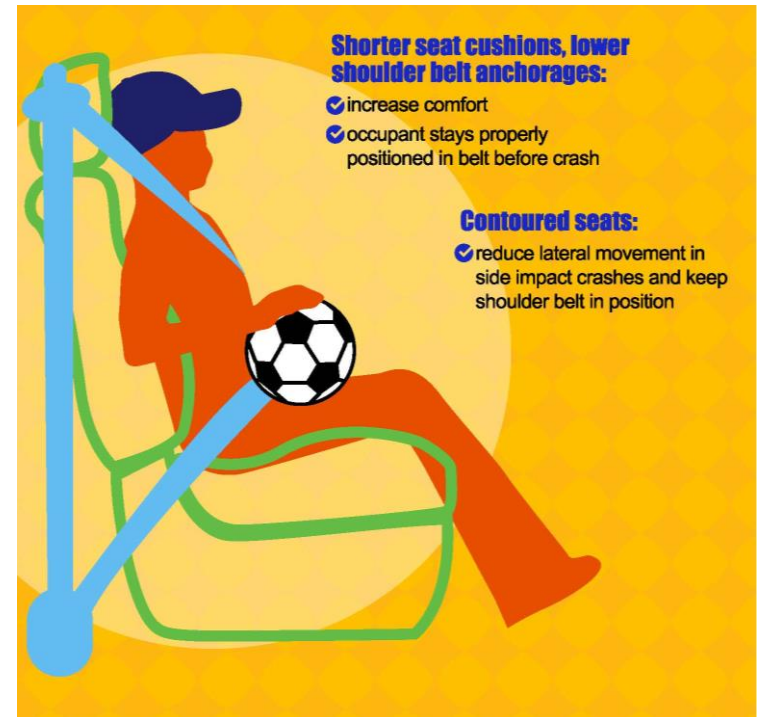
Rear Seat Engineering Considerations

Seat geometry

Seat belt anchorage
locations

Advanced seat belt
technology

Suboptimal positions



2. Make typical behavior safe

- Tremendous investment to educate parents re: best practice
- Ease-of-use ratings improve design
- Change narrative to “simple & positive”
- Cannot engineer out all incorrect behavior
 - design more forgiving systems



Collaborative Study led by Monash University

Participants

- 42 families recruited with at least 1 FFCRS

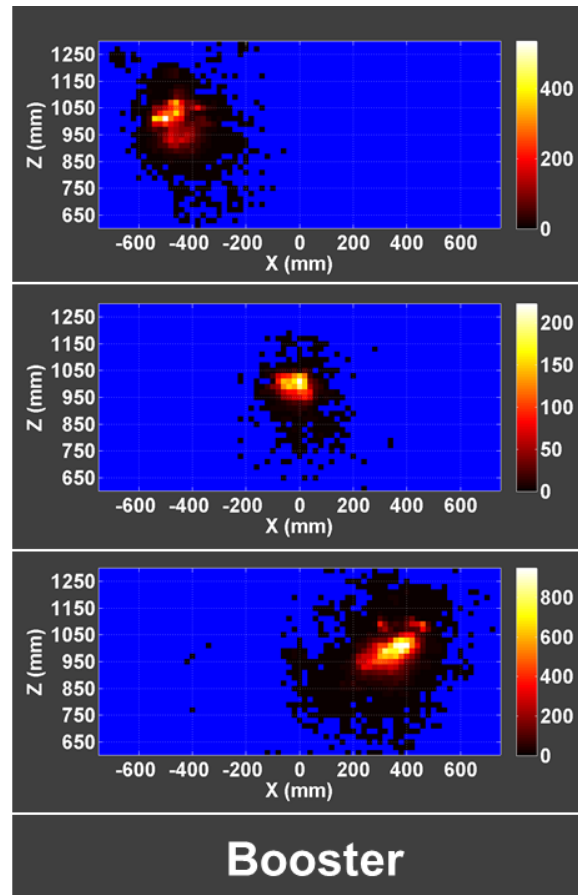
Methods

- Use of instrumented vehicle for 2 weeks
- Vehicle drop off – briefing session, demographics
- 1 week data check
- Vehicle pick up – education, knowledge and attitudes

Data collection complete October 2014

PI: Judith Charlton

Range of Head Positions View from Above



Implications for Restraints

- Children in the rear seat assume a wide variety of positions – range of 30 cm fore-aft, left-right
- Inboard leaning more common
 - Moves occupant away from the shoulder belt
 - Compromises protection
- Restraint development opportunities
 - Recognize these positions and correct them
 - Account for diverse occupant positioning when considering restraint design

Summary observations – field data

- Children under age 13 account for over half of rear seat occupants
 - Adults account for only 1 in 5 rear seat occupants
- Restrained children 8 years and younger continue to be well-protected in the rear
 - Evidence of increased relative risk of death in the rear for 9-12 year olds requires further study
- Restrained passengers 55 years and older
 - Highest risk of serious and fatal injuries
 - Increased relative risk of death in the rear compared with front passengers

Challenges ahead

- Improve safety for older adults while maintaining the current safety for younger occupants
- Evolution of consumer information programs will stimulate advances in rear seat technology
 - Must evaluation protection for and unintended consequences to all ages
- Protect humans not crash test dummies

Acknowledgements

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- Katarina Bohman PhD



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